DEVELOPMENT AND EVALUATION OF A PERIOPERATIVE MEDICATION MANAGEMENT DECISION SUPPORT TOOL

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Authors certify that they have no conflict of interest in creating or presenting this work
Learning Objectives

- Clinical decision support (CDSS) development
- CDSS maintenance
- Use of clinical heuristics
- Challenges of managing national drug formulary CDSS
Pre-operative Evaluation in a Nutshell

- Established decisions on use of medications
  1. Indication and need
     I. Effect of stopping drug on primary disease
     II. Rebound effect
     III. Clinical deterioration
     IV. Withdrawal
  2. Drug pharmacokinetics & changes
  3. Absorption, half-life, ROA
  4. Potential adverse effects
     I. Bleeding, hypoglycemia, ...
  5. Appropriate management of pain
  6. Administration of adjunctive medications
  7. Use of appropriate formulations and alternative products when needed
  8. Potential benefits of starting a drug prophylactically

- Hx
  - Chief problem
  - Surgery type
  - Type of anesthesia

- PMH (allergies, co-morbidities, injuries, …)

- Social Hx
  - Problems with bleeding, anesthesia, …

- Physical exam
- Labs/tests
- Imaging reports
- A&P
  - surgery risks
  - effect of surgery on underlying disease(s)
  - PMM
Why Study PMM Informatics

- Medical decision making is difficult!
  - Substantial amount of knowledge required to solve even seemingly simple problems
  - Requires massive amounts of information recall and application
  - Cognitive ability becomes challenged
    - Multi-tasking
    - Limited reasoning
    - Memory capacity
Why Study PMM Informatics

- Decision making is particularly challenging in perioperative medicine:
  - Recall of information and processing of clinical data spanning multiple clinical specialties
  - Knowledge of medication-related issues
    - Particularly challenging with patients who take several medications!
  - Need to close decision making loop to communicate results with patients to manage care transitions
Why Study PMM Informatics

- Increasing Surgical Burden
  - Aging population with greater functional recovery expectations

- As many as 44% of patients undergoing surgery take medications prior to surgery\(^1\)

- Half of the general surgical patients take medications unrelated to surgery\(^2\)

- Increased RR (2.7 times) of post-operative complications in patients who take meds not related to surgery vs patients taking no meds\(^2\)

Why Study PMM Informatics

- Medication errors contribute to patient morbidity and mortality\(^1\)

- Ineffective care transition processes lead to adverse events\(^2\)

- Although a general consensus exists for perioperative management of some medications, consensus is lacking for others\(^4\)
  - Perioperative medication management decisions are often empirical and inconsistent among clinicians

Clinical Decision Support Systems

- Rule-Base (Expert System) CDSS
  - a special class of CDSS in which computer emulates the decision-making ability of a human expert.  
    
  - a “discipline that involves integrating knowledge into computer systems in order to solve complex problems

  - normally requires a high level of human expertise.”  

Knowledge Discovery and Management

- Essential for developing a model to formally represent the PMM domain knowledge
- PMM ontology of concepts and relationships
  - Structural framework for use and organization of clinical information
  - Captures flow of information and data
  - Developed in consultation with two domain experts in internal medicine
Data Sources

- **Clinical Notes**
  - 100 randomly-selected pre-op notes between 8/1/2010 and 7/31/2012
  - Records originally created in CPRS EHR system
  - De-identified
  - Active outpatient meds and med. mgmt recommendations (actions)
Active Outpatient Medications

1) **GABAPENTIN** 300MG ...
2) **GLIPIZIDE** 10MG ...
3) **SIMVASTATIN** 80MG ...

--Medication recommendations

Give the following meds with a sip of water AM of surgery:

- **gabapentin**
- **Start holding glipizide** the evening pre-op.
Drug Classes & Categories

- **Class source:** VA’s National Drug File (NDF), 6/2012 version
- **Categories source:** VA’s Class Index File, 7/2012

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</table>

BL110 = Anticoagulants
Create PMM recommendations development dataset manually:

- Age
- Gender
- Surgery type & risks
  - Bleeding (tooth extraction vs limb amputation)
  - Infection
  - Wound Heal
- Active Meds
- Creatinine
- INR
- Classes
- Actions (recommendations/decision heuristics)
Decision Heuristics (rules)

- Three domain experts (General Internists)
- One round of review
  - manual inspection of all drugs and actions in dataset
- Decision Criteria
  - Whether a drug is actionable, non-actionable, or unknown
  - Whether the action on a drug is the correct action
- Discrepancies noted and adjudicated
Supported Decisions

- Decision in EHR matched decision by reviewers
- \( \geq 80\% \) of the time

OR

- If \(< 80\%\) agreement, decision adjudicated by a 4\(^{th}\) domain expert referee

OR

- Supporting evidence from E.B. literature
drug action heuristics for the entire VA drug formulary based on a tiered supporting evidence structure
<drugclass>
  <id>AN300</id>
  <instructions>No action recommended</instructions>
  <exception>
    <drug>
      <name>METHOTREXATE NA 2.5MG TAB</name>
      <instructions>Safe to continue if normal creatinine level, otherwise hold 7-14 days prior: &lt;a href="http://www.ncbi.nlm.nih.gov/pubmed/?term=11171680+17204310" target="_newpage"&gt; SUPPORTING EVIDENCE &lt;/a&gt;&lt;p&gt;If minor surgery, safe to continue: &lt;a href="http://www.ncbi.nlm.nih.gov/pubmed/?term=20033813" target="_newpage"&gt; SUPPORTING EVIDENCE &lt;/a&gt;&lt;/p&gt;

Evidence Level: B

</instructions>
  </drug>
</exception>
</drugclass>
Study 1

Results

Sources of supporting evidence (category-level)

- National Drug File (n=409)
  - Eliminated (n=172) → Not In Samples (n=302)
    - Remaining (n=130)
      - E.O. (n=130)
        - Adjudicated (n=110) → Non-adjudicated (n=20)
    - Sample Records (n=107)
      - E.O. (n=84) → E.B.L & E.O. (n=66) → E.B.L (n=18)
        - Agreed (n=75) → Disagreed (n=9)
        - Adjudicated (n=4) → Non-adjudicated (n=5)
Results

- 1,065 rules
  - 237 category-level rules covering ~10,000 drugs
    - Formulary for largest healthcare delivery system in the US
  - 828 exception rules

- Tiered levels of supporting evidence: 1,830
  - Level A: 184 (RCT)
  - Level B: 1,358 (Non-RCT)
  - Level C: 285 (Expert opinions)
  - Level D: 25 (Non-adjudicated expert opinions)
Use the “rules” file developed in Study 1 as the inference engine to build the CDSS

Test the accuracy of the CDSS against 100 (different) patient records in VistA/CPRS

Patients seen by our domain experts in Study 1 will be excluded (want the utility’s decisions to be bias-free)

Compare utility’s output (actions) with domain expert opinions and measure % of recommendation matches
PeriMed Design & Development

- Web-based
  - Javascript
  - HTML
  - Python (2.7)

- Platform-independent

- Vendor-independent
Results

PeriMed’s performance on “clinically significant drugs”

First-round testing: match frequency = 76%

1. Misinterpretations identified; rules adjusted
2. Outright differences noted; adjudicator agreed with tool in 69% of cases

Second-round testing: match frequency = 96%*

* Compares favorably with like CDSSs

Tool Demonstration
Sample size (n=100) was adequate for empirically building a patient-based CDSS
- 92% of clinically-significant medications represented in the sample

Validation of the proof of concept can be expanded for patient use
- Prospective identification of at-risk patients
- Follow-up assessment after preoperative evaluation to insure appropriate use of medications
- Potential for use in integrated screening work
PeriMed possesses 3 key features associated with CDSS success:\(^1\):

- electronic rather than paper-based templates
- provides decision support at the time and location of care rather than prior to or after the patient encounter
- provides recommendations for care, not just assessments

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Thank You!

☐ Questions?